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Topic 03 – Echocardiography / Cardiac imaging

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101

Left ventricular function assessment by 3D-speckle tracking transthoracic echocardiography in patients with light chains amyloidosis

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Background and objective: Transthoracic echocardiography (TTE) is usually performed for patients with light chains amyloidosis (AL) when cardiac involvement is suspected. The latter is typically characterized by left ventricular (LV) diastolic dysfunction. However, the LV systolic ejection fraction (LVEF) is usually preserved. Whether, the different components of the LV systolic contraction are altered in AL, is unknown.

The aim of this preliminary study was to assess the differents components of the global LV systolic function, (longitudinal, radial, circumferential, area tracking and twist) using a 3D wall motion tracking imaging, a modern technique coupling a 3D volumetric acquisition with a wall motion tracking imaging, in a series of consecutive healthy controls and in patients with AL stratified according to the Mayo Clinic staging.

Methods and Results: 34 consecutive subjects (6 controls and 28 with AL and different degree of cardiac severity) were analysed. Classical 2DTTE parameters were obtained along with the 3DLV parameters: Mean age was 64±10 years, 66% were male. Compared to controls and to those with minimal/mild (stage I/ II) cardiac involvement, those with severe cardiac involvement (stage III) had significantly lower 3DLVEF, 3D LV global: longitudinal, radial strain, 3D strain, circumferential and area tracking (table) (all p< 0.05). However the 3D LV twist function was not different between the 3 groups. Traditional 2DTTE showed significant differences in diastolic function in stage III AL compared to those in stage I/ II and controls; however, there was no significant differences in 2D LV volumes and EF.

Conclusion: our preliminary study is the 1st to assess all components of global LV contraction using simultaneous 3D full volume acquisition and wall motion tracking imaging. Larger studies are needed to confirm these results and to assess their impact on outcome and management of AL patients.

102

Right ventricular function assessed by two-dimensional strain measures in acute ST-elevation myocardial infarction without a coexisting right ventricular infarction

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The frequency and clinical correlates of global right ventricular (RV) dysfunction in patients treated with primary percutaneous coronary intervention for a first acute ST-elevation myocardial infarction (STEMI) without a coexisting RV infarction is not well known.

Abstract 101 – Table. Results

VARIABLES	Controls (n=5)	Stage I (n=6)	Stage II (n=8)	Stage III (n=15)	P value
Age	623±10	63±6	65±11	65±11	0.97
Sexe (% male)	67%±17	67%±17	63%±22	67%±42	0.99
2D LV echo parameters					
LVEDD (mm)	47±5	46±4	43±6	48±7	0.35
LVESD (mm)	31±5	28±4	28±6	30±4	0.69
LVEDV (ml)	96±24	68±14	80±25	84±22	0.09
LVEDS (ml)	43±15	24±6	36±9	37±14	0.35
LVEF (%)	59±4	63±8	55±6	56±12	0.35
IVSeptum (mm)	10±1	11±1	14±2	16±8	<0.0001
E/E' lateral	6±4	11±3	17±3	18±2	0.002
E/A	0.9±1	2±1.5	2±2	2±2	0.06
Deceleration time	236±37	182±20	205±45	178±59	0.2
LA volume index (ml/m^2)	20±4	29±10	34±9	37±12	0.03
3D LV Echo parameters					
LVEF (%)	47±4	51±4	49±4	86±8	0.007
EDV (ml)	86±10	82±10	85±9	98±6	0.4
ESV (ml)	46±8	40±8	43±7	66±5	0.01
OLS (%)	–13±2	–13±2	–10.6±2	–8.3±1	0.02
CIRCUMS (%)	–20±2.5	–24±8	–22±4	–15±6	0.01
RADIALS (%)	29±5	26±6	15±4	9±3	0.002
Area Tracking (%)	–30±3	–35±3	–31±3	–23±2	0.01
BD-STRAIN (%)	30±6	29±5	19±10	10±2	0.001
TWIST (%)	5±1	7±1	4±2	4±1	0.18

Materials and methods: We enrolled 150 consecutive patients, all them underwent conventional echocardiography within 72 hours after a successful primary percutaneous coronary intervention .A complete echocardiographic evaluation (dimensions, global systolic parameters, and visual assessment and deformation imaging of the RV free wall including Doppler tissue imaging and two-dimensional strain echocardiography) was obtained. Peak systolic strain less negative than –18% and/or postsystolic shortening (postsystolic index > 15%) in any RV segment was considered abnormal.

Results: Global RV dysfunction was present in 34% of the patients (peak systolic strain less negative than –18% in 29% , and post-systolic shortening in 16%) . We observed more diabetic in the patients with global RV dysfunction (62% vs 42%, p=0.002), more metabolic syndrome (32% vs 21%, p=0.01) . We found a significantly higher glucose levels on admission (1.8±2.4 vs 1.43±6.6 g/L; P=0.007), higher C reactive protein (40±21mg/l vs 26± 19; P=0.014), than those without RV dysfunction. Patients with global RV dysfunction also had a significantly lower left ventricular (LV) assessed by ejection fraction (45.1±10.8% vs 51.1±9.7%; P=0.021) and the left ventricular global longitudinal strain (–12.2±2.2% vs 9.2±3.4%; p=0.014) than patients without. With the use of multivariate regression analysis, global LV longitudinal strain less than – 9.5% (OR, 1.41; 95% CI, 1.18–2.92; P=0.03) was independently associated with the presence of global RV dysfunction.

Conclusions: In patients with a first acute STEMI without an associated RV infarction, depressed global LV function reflected by decreased global longitudinal strain is independent correlate of early global RV dysfunction. Routine assessment of global RV function should be implemented in patients with STEMI with these characteristics.

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103

Relationship between acute strain pattern and recovery in tako-tsubo cardiomyopathy and acute anterior myocardial infarction: a comparative study using two-dimensional longitudinal strain

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It is unclear whether in tako-tsubo cardiomyopathy (TC), characterized by myocardial stunning, the strain pattern mimics the acute post ischemic left ventricular (LV) viable myocardium, which shows some degree of active deformation (longitudinal shortening) despite wall motion abnormalities (WMA). Our objective was to compare the strain pattern in TC and acute anterior myocardial infarction (MI) using the 2D-longitudinal strain (LS) by speckle tracking in segments (Se) with WMA, and its relationship with recovery at follow-up (FU).

Methods: 20 consecutive patients (pts) with typical TC (mean age 81±5 years, 18 women, mean LVEF=41±5%) and 20 pts with MI treated by primary angioplasty, matched for age and sex (mean LVEF=46±5%, ischemic time 5.5±3 h), had a transthoracic echocardiography including analysis of LV LS from the apical long-axis, 4-and 2-chamber views (18 segments) at the acute phase (within one day after angiography), and at FU (1 month later for TTC and 3 to 6 months later for MI). The recovery (R) of a Se was defined as a normal wall motion at FU.

Results: Among the 710 analyzable LV Se at the acute phase, 362 had WMA, 213 in TC, and 149 in MI. Total R was observed in all Se at FU in TC, and in 75 Se in MI ($p<0.01$). In TC Se with WMA, the duration of systolic lengthening (SyL) (47±40% vs. 20±35%), and lengthening to shortening ratio (L/S) (0.25±0.29 vs. 0.1±0.19) were significantly higher, and the systolic segmental LS lower (–1.5±6% vs. –3±6%), when compared to MI Se ith WMA and R (all, $p<0.01$), but were not different to MI Se with WMA without R (all, p=NS). In MI but not in TC, SyL was an independent predictor of recovery in multivariate analysis, and was closely linked to segmental LS at FU (all, $p \leq 0.01$). Among the Se with WMA, 36% had a SyL ≥67% and 25% a SyL=100% in MI vs. 40% and 30% respectively in TC; and 80% of Se with SyL, did not recover at FU in MI, vs.100% recovery in TC ($p<0.01$).

Conclusion: The systolic passive motion which is closely linked to R in MI is paradoxically frequent and severe in TC. Therefore, according to LS, the myocardial stunning in TC and MI is different.

104

Altered two-dimensional strain measures of the right and left ventricle in patients with arrhythmogenic right ventricular cardiomyopathy and their first degree relatives.

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Introduction and aim: The identification of right ventricular abnormalities in patients with arrhythmogenic right ventricular cardiomyopathy (ARVC) in early stages is still difficult. The aim of this study was to investigate if longitudinal strain based on speckle tracking can detect subtle right (RV) or left ventricular (LV) dysfunction as an early sign of ARVC.

Methods and results: We have investigate 26 patients, fulfilling Task force criteria for ARVC, 16 were male , 34 (17-77) years old, 35 first degree relatives (21 were male, 29 years mean old and 20 healthy subjects (12 were male, 29 years mean old). Patients and relatives were explored by un electrocardiogramme and un echocardiography. Morphologic and functional study were performed for LV and RV (diameters, volumes, peak systolic velocity from tissue Doppler and longitudinal strain based on speckle tracking were measured from the basal and mid segments in both ventricles). RV longitudinal strain measurement was feasible in first degree relatives and controls on 85 and 76% but less in patients (62%). On first degree relatives, Segmental longitudinal pick systolic strain on RV (mild and basal lateral segments) was significantly lower than that of controls (–28.9±3.2% vs. –32.3±3.2%, p= 0.002 and (–26.6±3.4% vs. –31.3 ±2.6%, P: 0.03 respectively) but significantly greater than that evaluated in ARVC patients (–20.6± 4.7%, $p<0.001$ and –19.5±4.2%, $P<0.01$). For the left ventricular global strain , no differences were found between the control group and the first degree relatives (22.6±5.5% vs. –21.3±6.6%), but we found a difference between control group and patients (–17.3 ±4.2%, $p<0.01$).

Conclusion: Longitudinal strain of LV and RV segments was significantly lower in patients than in relatives and controls. The global and segment longitudinal function assessed by echocardiographic might help to detect early ARVC disease in firs degree relatives.

105

To analyze right ventricular (RV) myocardial deformation in patients with left ventricular (LV) hypertrophy secondary to hypertrophic cardiomyopathy (HCM) and hypertension

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Methods and results: Standard Doppler echo and 2D speckle-tracking strain echocardiography (2DSE) of RV longitudinal

deformation in RV septal and lateral walls were performed in 80 patients with familial HCH and in 40 patients presenting hypertension having evidence of LV hypertrophy and 30 healthy patients . Right ventricular global longitudinal strain (GLS) was calculated by averaging local strains along the entire right ventricle.

The two groups were comparable for age.

Interventricular septal thickness and mass were higher in HCM, whereas LV end-diastolic diameters (LVEDD), left atrial (LA) volume and LV stroke volume were increased in hypertension patients.

Right ventricular tricuspid annulus systolic excursion was comparable between the two groups but lower than the control group. Conversely, RV GLS and regional peaks of RV myocardial strain were significantly impaired in patients with HCM less in hypertension group (–21±4% vs –16.2 ±4.3%, p=0.001 vs 24±3% in control group, p=0.0001). Multiple linear regression models detected an independent association between RV GLS and LA volume (β coefficient 23.6, p= 0.001) in hypertension group, as well as an independent correlation of the same RV GLS with septal thickness and left atrial function (β =0.63, p= 0.01 and β= 0.55, p=0.001) in HCM. An RV GLS cut-off value of –18% differentiated hypertension patients with LV hypertrophy and HCM with an 87% sensitivity and a 92% specificity.

Conclusion: Right ventricular myocardial systolic deformation is altered both in hypertension disease and HCM and is associated with increased septal thickness in HCM and LA function. Therefore, 2DSE may represent a useful tool in the differential diagnosis between LV hypertrophy secondary to hypertension and HCM, underlining the different involvement of RV myocardial function in different pathway of pathological LV hypertrophy.

106

Three dimensional echocardiography strain imaging in patients with mitral regurgitation: a preliminary study.

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Introduction: three-dimensional speckle tracking imaging (3D-STI) is a recently available tool in the evaluation of myocardial function. Aim of the

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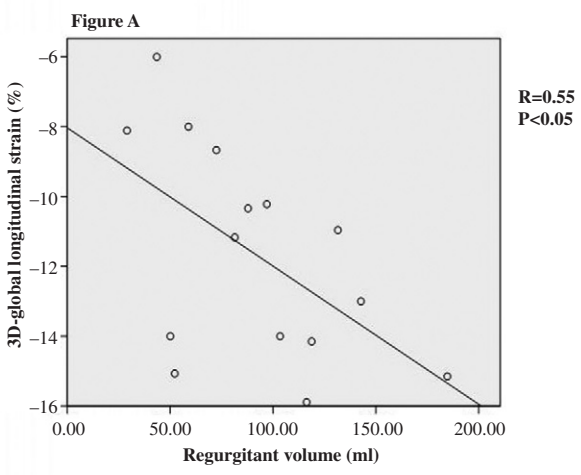
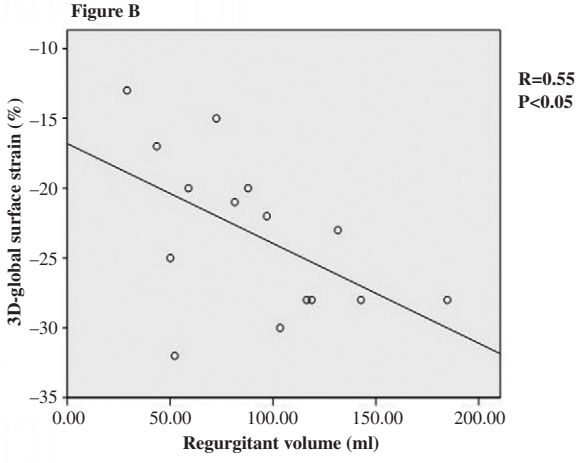
present study is to verify the feasibility of 3D-STI in patients with mitral regurgitation (MR).

Methods: 2D and 3D echocardiography were performed in 31 patients (mean age: 58.0±15.1 years; male sex: 19, 61%): 19 subjects with moderate or severe organic MR due to mitral prolapse or fibrosis and 12 subjects with normal hearts. All patients were in sinus rhythm, had suitable acoustic windows and preserved left ventricular (LV) ejection fraction.

Results: 3D-STI was performed in all enrolled patients. With respect to normal patients, MR patients were older (64.1±14.9 vs 48.3.±9.1; P<0.01), with larger 3D-LV end diastolic volumes (141.3±63.9 vs 95.9±25.6 ml, P<0.05), higher 3D-sphericity index (0.50±0.12 vs 0.32±0.05, P<0.0001) and worse diastolic function as expressed by mean E/E_a ratio (11.6±5.4 vs 6.8±1.6, P<0.01). Not significant differences were observed in LV ejection fraction and in 3D-STI between the two groups. In MR patients, a significant relationship existed between 3D-global longitudial strain rate (GLS), global surface strain (GSS) and the entity of regurgitant volume (RV) measured by 2D PISA method (R=0.55, P<0.05 and R=0.53 P<0.05 respectively) (Figure A and B).

Conclusions: determination of 3D-STI is feasible in patients with MR and correlates with RV. Further studies on larger populations are needed to identify the role of 3D-GLS and GSS as an index of MR severity in organic mitral regurgitation and its potential relationship with disease progression.





Figures A and B – Correlations

107

Tricuspid valve assessment using 3D echocardiography in children with and without congenital heart disease.

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Tricuspid valve (TV) assessment is essential in various congenital heart diseases. 2D echo remains the cornerstone of TV annulus (TVA) measure but is limited by its complex shape. We investigated in children, the feasibility of 3D-Transthoracic echo (TTE) in TVA assessment compared with 2D.

Methods: Diameters of TVA were performed on three 2D sectional views (parasternal short axis (PSA), apical 4 chambers (A4C), parasternal right ventricular inflow (PSRVI)). "En face view" of the TV was obtained with real time zoom 3D in A4C (3D-matrix array X7-2, X5-1,X3-1 probes,iE33 Philips®). Offline measures of maximal (^{m}TVAd) and minimal ($_{m}$TVAd) diameters were performed using multiplanar reconstruction on Qlab® Software. An asymmetric ratio was calculated (^{m}TVAd/$_{m}$TVAd).

Results: 64 children (7.1±5.4 years; weight 2.2-82 kgs) with (42.2%) and without (57.8%) cardiopathy were prospectively included. Feasibility of 3D TV dataset was possible in all cases. Quality was estimated good in 69.8% of cases. Leaflets visualization was possible in all unless in 3 childsren (95.2%) and was better when 3D dataset quality was good (p<0.0001). ^{m}TVAd was from septal to lateral axis. Pearson Correlations were good between ^{m}TVAd, $_{m}$TVAd and 2D sectional diameters (r≥0.8 in all cases, p<0.0001). TVA was asymmetric with a ratio>1.2 in 43 children (67.2%) without significant difference according to the cardiopathy. Difference between ^{m}TVAd and $_{m}$TVAd was 10.3±13.2mm/m2 (p<0.0001). PSA was higher than ^{m}TVAd (p=0.001) whereas ^{m}TVAd was higher than PRSVI (p<0.0001) and closed to A4C although superior (p=0.03). ^{m}TVAd was higher than A4C when ^{m}TVAd <25 mm and the contrary was seen for ^{m}TVAd >25 mm.

Conclusion: Feasibility of 3D imaging of the tricuspid valve is good in children with or without cardiopathy. According to 3D TVA diameters, the 2D A4C seems to be the most reliable sectional view, while the 2D-PSRVI underestimate the TAD. Conversely, the 2D PSA seems to overestimate TVA compared to 3D measures.

108

Impact of positive inotropic drugs on echocardiographic assessments of left ventricular filling pressure in patients with decompensated end-stage heart failure

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Background: Ratio of early diastolic transmitral flow velocity to tissue Doppler mitral annular early diastolic velocity, E/e′, and pulmonary capillary wedge pressure (PCWP) have been shown to be correlated. The validity of E/e' for predicting PCWP in patients with decompensated end-stage systolic heart failure (DESHF) was recently challenged, but the influence of inotropes was not taken into account, despite the reported influence of these drugs on left ventricular relaxation properties. We investigated the impact of inotropes on the accuracy of E/e' ratio as a surrogate for PCWP in DESHF patients.

Methods and Results: Invasive hemodynamic monitoring and echocardiographic data were collected prospectively, in 40 DESHF patients (93% male), aged 56±13 years. These patients had dilated ventricles with a low cardiac index (2±0.7 l/min/m2) and high PCWP (22±8 mmHg), and 90% required inotropic support during hospitalization. For 12 patients, at least two evaluations were available, before and after inotropic support. The correlation between septal E/e' and PCWP was good for examinations in the absence of inotropes (n=21) (r=0.7; p<0.001), but no correlation was found when inotropes were used (n=32). Lateral and mean E/e' were poorly correlated with PCWP, if at all, in both cases. We found no association between changes in PCWP and changes in mitral E/e' ratio for examinations performed before and after inotrope introduction (figure next page).

▶

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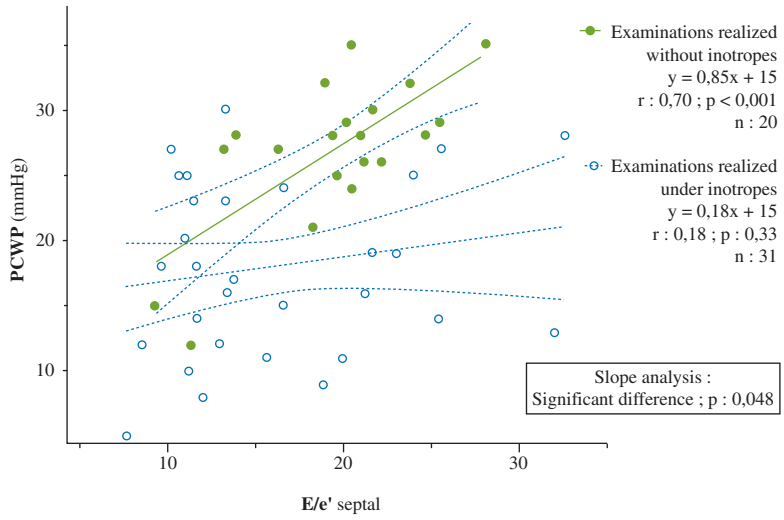

Abstract 108 – Figure – Results

Conclusions: By modifying ventricular relaxation properties and the influence of filling pressure on e', inotropic agents severely impair the correlation between E/e' and PCWP in DESHF patients.

109

Assessment of right ventricular dysfunction predictors before the implantation of a left ventricular assist device in end-stage heart failure patients using Echocardiography measures (ARVADE)

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Background: Right ventricular failure (RVF) is a major cause of morbidity and mortality in LVAD recipients.

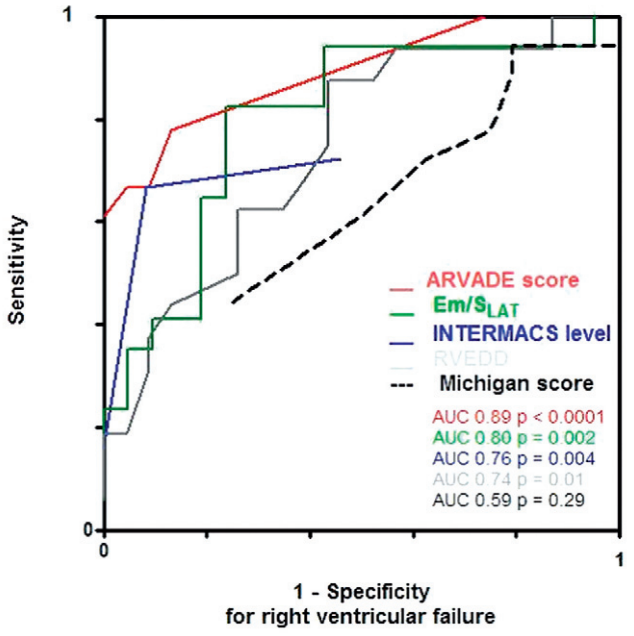
Objectives: To identify pre-operative echocardiographic predictors of post-LVAD RVF.

Methods: Clinical, hemodynamic and echocardiographic data were collected for 42 patients undergoing VAD implantation in Germany.

RVF was defined as the need for placement of a temporary RVAD, or the use of inotropic agents for 14 days. Data for RVF patients were compared with those for patients without RVF. A score (ARVADE) was established with independent predictors of RVF, by rounding the exponentiated regression model coefficients to the nearest 0.5.

Results: RVF occurred in 24 of the 42 LVAD patients. Univariate analysis identified the following echocardiographic measurements as risk factors for RVF: basal RV end-diastolic diameter (RVEDD), minimal inferior vena cava diameter, mitral E wave (Em), and Em/ lateral tissue Doppler S (S_{LAT}) and Em/S_{SEPT} ratios. Em/S_{LAT} ≥18.5 (RR 2.2, CI [1.21 – 3.99]; p=0.004), RVEDD ≥50 mm (RR 1.74, CI [1.04 – 2.91]; p=0.037) and INTERMACS levels 1 and 2 (RR 5.4, CI [1.50 – 20.1]; p<0.0001) were independent predictors of RVF. An ARVADE score > 6 predicted the occurrence of post-implantation RVF with a sensitivity of 78% and a specificity of 87%. ARVADE score outperformed the independent factors identified in our study and Michigan score for predicting the occurrence of postoperative RVF (Figure 1).

Conclusion: The LV echocardiographic parameters were the best predictors of post-LVAD RVF, showing the strong contribution of the LV to the RVF. The ARVADE score, combining one clinical parameter and three echocardiographic measurements is potential useful for selecting patients for the implantation of an assist device.



Abstract 109 – Figure 1.

110

Usefulness of serum markers of collagen metabolism to detect myocardial fibrosis in patients with hypertrophic cardiomyopathy: from a multimodality analysis

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Background: Hypertrophic cardiomyopathy (HCM) is the most frequent genetic cardiovascular disorder and represents one of the most common cause

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of heart related sudden death in young adults. Myocardial fibrosis seems to be an independant predictor of adverse events such as sudden death and heart failure. New methods are available to evaluate myocardial fibrosis such as late gadolinium enhancement (LGE) detected by cardiovascular magnetic resonance (CMR), impairment of left ventricular global strain (LVGS) and serum markers of collagen turnover.

Objectives: To find a statistical association between LGE, impairment of LVGS and serum markers of collagen turnover in a population of adults with HCM and to create a multimodal analysis of patients with predictable adverse outcome.

Methods: It is a prospective monocentric study including all consecutives patients with HCM on cardiomyopathy specialysed center (Marseille). Patients with covert HCM had at the inclusion a complete clinical evaluation, the analysis of 2 serum markers of collagen turnover: TIMP-1 (Tissue Inhibitor of MetalloProteinase 1) and PIII-NP(Procollagen III N-Propeptid), a CMR and analysis of LVGS.

Results: 78 patients (mean age 50±3 ans, 59 males) were included. LGE was observed in 44 cases (56%). Mean LVGS was –16.3%±3.85. There was no significant relationship between GLE, LVGS impairment and serum levels of TIMP-1 and PIII-NP. TIMP-1 serum levels were significantly higher in patients with lower left ventricular mass index (LVMI) (p=0.03) and smaller left ventricular wall thickness (p=0.009).

Conclusion: The analysis of the serum markers of collagen turnover (TIMP-1 and PIII-NP) did not provide any additional information for the detection of myocardial fibrosis compared to multimodal imaging analysis based on GLE and LVGS. The higher level of TIMP-1 in patients with lower LVMI suggests a stronger activity in collagen turnover and pro fibrotic activity than in patients with higher LVMI.

111

The TAPSE: a predictive parameter of cardiovascular events in dilated cardiomyopathy

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Introduction: TAPSE is a method for evaluation of the right ventricular systolic function by measuring the distance of tricuspid annular movement between end-diastole to end –systole. This parameter has been studied to identify the value of TAPSE predictive of mortality and rehospitalization for decompensated heart failure in patients with dilated cardiomyopathy.

Material and Results: In our series, 61 patients having dilated cardiomyopathy were followed for a mean period of 11 months. we found that patients who died have a lower value of TAPSE than survivors (10.80±3.27 mm vs. 15.5±5.22 mm, p=0.05). This parameter was also significantly reduced in patients hospitalized for decompensated heart failure (12.11±3.18 vs 16.84±5.13 mm mm, p <10-3). We also noted that a TAPSE <12 was predictive of mortality with a risk of death multiplied by 13 (p=0.02). After multivariate logistic regression analysis and a model including the echocardiographic parameters significantly associated with a death event, we found that the most statistically significant factor was a TAPSE <12 mm (p=0.07). This parameter is a direct factor of death, if the duration of follow-up was longer and the number of deaths was more important. We also concluded that a TAPSE <15 was predictive of hospitalization for decompensated heart failure with a risk multiplied by 5.8 (p=0.003) and a TAPSE <11.5mm was predictive of cardiac event(death, decompensatory heart failure, ventricular arrythmia) with a global risk multiplied by 8 (p=0.001).

Conclusion: Several echocardiographic parameters may have a prognostic value of cardiomyopathy, the TAPSE is considered an important parameter for risk stratification in patients with heart failure secondary to dilated cardiomyopathy.

112

Right ventricular function before and after percutaneous balloon mitral valvuloplasty

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Introduction: Abnormalities of right ventricular function play an important role in the development of clinical symptoms and the prognosis of patients with mitral stenosis.

Aims: To assess the immediate effect of percutaneous balloon mitral valvuloplasty on right ventricle function.

Methods: Fifty nine patiens (mean age: 31,02±8,28 years, 65% female) with isolated rheumatic mitral stenosis were studied before and 24-48h after percutaneous balloon mitral valvuloplasty. Indications for percutaneous balloon mitral valvuloplasty were New York Heart class ≥II, planimetered mitral valve area <1.5cm^2, mitral regurgitation ≤ 2, suitable valve morphology, and absence of concomitant cardiovascular disease requiring surgical correction. The control group consisted of nine women, none had evidence of cardiovascular disease. Echocardiography was done at the end of the procedure to assess for perforation.

Results: There is 55% patients were in New York Heart Association class II and 15% were in class III before percutaneous balloon mitral valvuloplasty, the mean mitral valve area was 1,02±0,26cm^2, and the mean value of pulmonary systolic arterial pressure was 50,22±26,95 mmHg. Percutaneous balloon mitral valvuloplasty was successfully completed in 58 patients, there was one case of severe mitral regurgitation, the mean transmitral gradient decreased from 13,86±7,40mmHg to 5,59±4,01 mmHg (P<0.0001),the right ventricle Tei index significantly decreased (P<0.0001), the right ventricle ejection fraction increased from 50,72±10,72 to 58,68±9,93 mmHg (P<0.0001), excursion of the tricuspid annular plane remained stable, doppler myocardial velocities at the septal annulus (S1,S2) were increased (p respective <0.034 and <0.0001) however at the lateral tricuspid aren't changing. Dp/DT increased in our study after percutaneous balloon mitral valvuloplasty (both p<0.0001).

Conclusion: Right ventricular function in mitral stenosis is reversibly impaired; this is predominantly caused by the hemodynamic consequences of the valvular defect.

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113

Left atrial appendage closure monitored by intracardiac echography probe through oesophageal route

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Background: Intracardiac echocardiography probe can be used trough esophageal route (ICE-TEE) to monitor left atrial appendage (LAA) closure without requiring general sedation.

Methods: The study included 16 consecutive patients (75±7 years) in atrial fibrillation with high risk of embolism (CHAD-Vasc=5±1.4) that required LAA closure by Amplatzer Cardiac Plug (ACP). Standard TEE was performed the day before the device implantation for LAA sizing and excluding thrombosis. During the procedure, ICE-TEE was used under local anesthesia to determine ACP diameter (ACP diameter=1.2*LAA diameter by ICE-TEE) and monitor ACP positioning. LAA size by ICE-TEE was compared to the size obtained by fluoroscopy and standard TEE and ACP lobe size after device implantation by ICE-TEE to cardiac computed tomography (CT).

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